Dwarfing effects of plant growth regulators on narcissi

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Abstract: The effects of four kinds of plant growth regulators with different concentrations on narcissi were studied in 2001. The results showed that the regulators could inhibit the growths of height and leaves of narcissi. Of the four regulators, the dwarfing effects of paclobatrazol (PP_{333}) and uniconazole (S_{3307}) on narcissi were better than those of chlorocholine (CCC) and dimethyl amino-sussinamic acid (B_9). All of the regulators did not have significant effect on the root length. Moreover, the time of flowering was later for the narcissi treated with regulators than that of the control to a certain extent, and the range delayed was from 2 days to 19 days. The correlation analysis results showed that there was a significant correlation between the time of flowering and the concentrations of regulators. The ornament value of narcissi was obviously improved by using the regulators.

Key words: *Narcissus tuzetta* var. *chinesis* Roem; Plant growth regulators; PP_{333}; S_{3307}; B_9; CCC
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Introduction

Narcissus tuzetta var. *chinesis* Roem is a perennial herb, which is one of ten kinds of famous flowers in China. It had a long cultivated history and mainly distributed to Japan, Korea, and the provinces of Fujian, Zhejiang, Jiangsu of China as well. .

Narcissi is a short day plant and has a particular requirement for light and temperature. Moist environment, fertile and loose soil and rich sunlight are very suitable for the growth of narcissi (Yang 1998). The optimal temperature of narcissi growth is in range of 20-30°C. During the indoor reserve and culture of narcissi, we often found the phenomena of the overgrowing leaves, slender pedicel and softening mechanical tissue, which would result in falling over and affect the visual impression. Thus dwarfing experiments of narcissi have been conducted with different plant growth regulators. The results showed that vegetative growth of narcissus plants was significantly inhibited and the ornamental value of narcissus cultured in water was enhanced (Zhang 1995; Qin 1998; Huang 2000). 30 $mg \cdot L^{-1}$ PP_{333} solution could effectively inhibit the growth of narcissus leaves and pedicels in the early stage of water culture (Chen 2000). Putuo narcissi treated with 200 $mg \cdot L^{-1}$ PP_{333} had the best dwarfing effect (Sun 1999). By use of PP_{333}, vegetative growth of narcissus was significantly inhibited. The resistance of shoot to lodging and the development of root were increased. In addition, the use of PP_{333} may increase the contents of chlorophyll, protein and sugar, and the activities of SOD, CAT, POD and IAA in the leaves (Shi 2002; Fu 1995). Different concentrations of S_{3307} could inhibit effectively excessive growth of cucumber seedlings, decrease shoot height, increase specific leaf weight and healthy index and root-top ratio, as well as enhance chlorophyll content and root activity (Yang 2003). After the seed of wheat treated by the S_{3307} solution, seedling height was reduced in the period from one core with one leaf to one core with four leaves stage (Zhou 2001). In this paper, narcissus was treated in four growth regulators with different concentrations. This study aimed to raise ornamental values of narcissus and study the effects of different plant growth regulators on dwarfing.

Material and methods

The samples came from Zhangzhou City of Fujian Province, China, with the same size. Four kinds of growth regulators were used in this study, which are paclobatrazol (PP_{333}), Uniconazole (S_{3307}), chlorocholine (CCC) and dimethyl amino-sussinamic acid (B_9). The samples were treated separately by the concentrations of 100 $mg \cdot L^{-1}$, 300 $mg \cdot L^{-1}$ and 500 $mg \cdot L^{-1}$, and each treatment was replicated three times. The control was cultured in clean water.

The sample was striped the brown out-layers and cut off the withering roots carefully, and then made a cutting downward in both sides of the main buds. The cutting length is about 2-3 cm and the depth is well situated to avoid injuring the leaf buds (Cui 2003). The bulbs were soaked in water for 24 h, and then taken out and cleaned them. Thereafter, the bulbs were cultured in different concentrations of regulator solutions and renewed the solution every 4 days. Eventually, when the samples were about to flower, the treatments were stopped, and the samples were transferred to clean water. This course needed sufficient light and suitable temperature.

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Results and analysis

Effects of different treatments on vegetative growth

The study results indicated that the four growth regulators used were all growth inhibitors. The growth of leaves was significant inhibited. With the increase of plant regulator concentrations, the effects of inhibition trended to strengthen. The result of variation analysis showed that there existed significant difference among the different treatments for every regulator, and even the extremely significant for PP_{333} (F=25.881**) (Table 1).

For pedicels, there were the same trends with the change of the leaves. The lengths of pedicels became shorter and shorter with the increase of concentrations, and the effects were different due to the different regulators. Among these, the difference between the different treatments reached a significant standard (F=7.210*) and extremely significant (F=24.840**) for S_{3307} and PP_{333} (Table 1). The results showed that the growth of pedicels might be controlled by the types and concentrations of regulator.

For root growth, the result of the variation analysis revealed that there was not a significant difference. Four plant growth regulators all did not have obvious activities to the growth of roots. Thus there was not certain relationship between narcissi root growth and the regulators.

Table 1. Effects of different treatments to growth and development of narcissi

Plan growth regulator	Concentrations /mg·L^{-1}	Root length /cm	Leaves length /cm	Shortening rate of leave /%	Height of scape /cm	Shortening rate of scape /%
Control	0	5.9	27.4 a	—	17.0 a	—
Uniconazole (S_{3307})	100	4.4	21.0 b	23	14.25 b	16
	300	7.75	17.0 bc	38	11.2 bc	34
	500	4.5	16.1 c	41	12.5 c	26
Paclobatrazol (PP_{333})	100	4.8	18.2 b	34	11.0 b	35
	300	4.5	14.0 c	49	8.50 c	50
	500	3.9	13.5 c	51	7.25 c	57
Chlorocholine (CCC)	100	8.4	25.9 a	5	15.1 a	11
	300	7.5	20.5 b	25	15.0 b	12
	500	7.8	19.5 b	29	11.75 b	31
Dimethyl amino-sussinamic acid (B_9)	100	9	26.5 a	3	15.0 a	12
	300	7.75	19.0 b	31	14.0 b	18
	500	5.5	16.75b	39	13.0 b	24

Note: a, b, c represents separately significance among different treatments (P=0.05)

Growth of narcissi after stopping treatment for one week

When the flowers were about to unfold, all of the treatments were stopped and the culture solutions were changed into clean water. The length of leaves was measured after one week. The results indicated that the growth of leaves had the same trends as above mentioned. Moreover, the growth of leaves treated with regulators was much slower than that of the control, and the difference reached a significant level (Table 2). This indicated the regulators remained in plant maybe still inhibited the growth of narcissi.

Table 2. The growth rate of leaves for one week after stopping treatment (cm/week)

Treatments	CK	100 /mg·L^{-1}	300 /mg·L^{-1}	500 /mg·L^{-1}
S_{3307}	9.3b	6.9b	2.3c	1.9c
PP_{333}	9.3a	4.8b	1.75c	1.1c
CCC	9.3a	5.7b	2.6c	2.5c
B_9	9.3a	8.0a	6.0b	3.65c

Note: a, b, c represents separately significance among different treatments (P=0.05)

Effects of different treatments on reproductive growth

Plant growth regulators not only controlled vegetative growth of narcissi but also affected the reproductive growth. This study found that the date of blossom was later and later with the increase of the regulator concentrations. Compared with the control, the scope of date delayed is from 2 days to 19 days (Table 3). At the same time, there were a very nice correlation equation between the treatments and the flowering date, and the correlation coefficient varied from 0.8871 to 0.9908 (Table 4.). We can found that all of the regulators inhibited obviously the reproductive growth of narcissi by slowing transportation and accumulation of nutrient materials.

Comparison of dwarfing effects of the different regulators

Of the four kinds of regulators, the dwarfing effect of the plants treated with S_{3307} and PP_{333} were more significant than the others. The data indicated that the lengths of leaves and pedicels of narcissi treated with 100 mg·L^{-1} PP_{333} solution was 34% and 35% shorter than that of the control, respectively. There was no obvious dwarfing effect under the treatments of 100 mg·L^{-1} CCC and B_9, but the

effects were very significant when the concentration was 300 mg·L^{-1} and the dwarfing ratio of leaves reached 25% and 31% of that of the control, respectively, and so were the pedicels (Table 1). Thus the PP_{333} had the best dwarfing effect for narcissi, and next was S_{3307}.

Table 3. Effects of growth regulators to flowering date of narcissi

Concentrations /mg·L^{-1}	S_{3307}		PP_{333}		CCC		B_9	
	Flowering date month/days	Days later /days	Flowering date month/days	Days later /days	Flowering date month/days	Days later /days	Flowering date month/days	Days later /days
CK	1/20	—	1/20	—	1/20	—	1/20	—
100	1/30	10	1/28	8	1/23	3	1/22	2
300	2/5	16	2/3	14	1/29	9	1/28	8
500	2/9	19	2/7	18	2/2	13	1/31	11

Table 4. The correlation equations between the growth regulators and the dates of flowering

Regulator kinds	Correlation equations	Correlation coefficients
S_{3307}	$y = 0.0369x + 37644$	$R^2 = 0.8871$
PP_{333}	$y = 0.0339x + 37643$	$R^2 = 0.9211$
CCC	$y = 0.0263x + 37641$	$R^2 = 0.9908$
B_9	$y = 0.0229x + 37641$	$R^2 = 0.9806$

Conclusion and discussion

The dwarfing activities of narcissi were influenced by the type and concentration of regulators. The regulators had certain action on the growths of leaves and pedicel, of which the dwarfing effects of PP_{333} reached an extremely significant standard. Of the four plant growth regulators, the dwarfing effects of PP_{333} on narcissi is best, next is S_{3307}. CCC and B_9 need higher concentration if there would be the same activities. After all of the treatments were changed into clean water for one week, the growth ratio of leaves have obvious difference, which indicated that the regulators remained in the plants still played an important role in inhibiting vegetative growth. Meanwhile the time of blossom was also delayed from 2 days to 19 days, and the color of leaves becomes deep green after narcissi were treated, which indicated the regulators might increase the contents of chlorophyll and intensify photosynthesis. Thus the regulators could make narcissi keep more beautiful and improve the ornament value. At the same time, the impairment from the regulators was still not found, but further study should be done in the future.

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